TRUCK MOUNTED ROTATING BROOM SYSTEM

Reference to Related Application

[0001] This application claims the benefit of Provisional U.S. Patent Application Serial Number 60/407,209 filed August 30, 2002.

Field

[0002] The present invention is a system for mounting, positioning, and powering a rotating broom; more particularly, the present invention is a system for mounting, positioning, and powering a rotating broom to be installed on the front of a self-propelled vehicle such as a truck. The truck-mounted system for mounting, positioning, and powering a rotating broom is used for the high speed sweeping and removal of snow or debris from large paved surfaces such as airport runways.

Background

[0003] The absence of snow or debris from large paved surfaces, particularly airport runways, is essential for tire traction which assures the safe passage of a vehicle, particularly a high speed vehicle such as an airplane, over the paved surface. Accordingly, operators of airports and those who maintain the surface condition of large paved surfaces have found it effective to sweep such large paved surfaces to remove buildups of snow or debris. To minimize the time required to perform sweeping operations, it has become an accepted practice to use large rotating brooms. These large rotating brooms are moved over the large paved surface by being mounted on the front of or being towed behind a truck. In the U.S., the preference has been to mount a rotating broom to the front of the truck so that the truck driver can observe the direction

in which the truck is headed and, at the same time, observe the effectiveness of the sweeping operation.

[0004] The use of snow or debris removal devices mounted on the front of trucks to remove fallen snow or debris from large paved surfaces is not a new one, as snow plows have been mounted to the front of self-propelled trucks almost as long as there have been self-propelled trucks. When rotating brooms were determined to be effective in removing accumulations of snow and accumulations of debris from large paved surfaces, such rotating brooms were mounted to the front of trucks in a manner similar the mounting of snow plows. Specifically, the mounting hardware was connected primarily to either the truck's front bumper, the forward portion of the truck's frame, or both. While the front bumper and the forward portion of the truck's frame are effective for holding the rotating broom, its mounting hardware, and its powering equipment, the impact of this heavy weight on the safe handling of the truck was often overlooked. Because the rotating broom, its mounting hardware, and its powering equipment were positioned further away from the front of the truck to enable angular repositioning of the rotating broom for directing the path of swept snow or debris to one side of the truck, the negative effects of the weight of the rotating broom on the drivability of the truck were exacerbated. Specifically, under certain conditions, some drivers of trucks with rotating broom systems mounted thereon noticed substantial leaning of the truck to one side or another.

[0005] One solution to the negative effects on the drivability of the truck from the weight of a rotating broom system mounted to the front thereof was to place a caster system under the rotating broom system to reduce the amount of weight transferred

directly to the truck. While such caster systems were effective in modifying weight distribution, the use of a caster system near the rotating broom created new problems in controlling broom direction and in maintaining sweeping quality. One cause of-these problems is the, fact that the bristles of the rotating broom continually shorten during sweeping operations. Solutions to the problem of the negative effects on the drivability of the truck have included adding counterbalance weight or using complex hydraulic control systems to both position or control the operation of the rotating broom and improve the drivability of the truck. Such systems have only demonstrated limited effectiveness, and the problems associated with drivability control remain.

[0006] Accordingly, a need remains for a robust system to mount a rotating broom system to the front of a truck so that there will be no negative impact on the drivability of the truck or detraction from the effectiveness of the sweeping operation.

SUMMARY

[0007] The disclosed system for mounting, positioning, and powering a truck-mounted rotating broom system of the present invention substantially reduces the negative impact of the weight of the rotating broom system on the drivability of the truck, while not reducing the effectiveness of the sweeping operation. Included in the disclosed system are two major components: a rotating broom mounting and control assembly, and a support structure. These two major components are connected by a non-rigid connection.

[0008] The rotating broom mounting and control assembly portion of the present invention, which is attached to the front of the non-rigid connection, includes those sub-systems necessary to position and turn the rotating broom. Such sub-systems assure

that the necessary bristle tip speed with respect to the paved surface is maintained for effective removal of snow or debris from the paved surface.

[0009] The support structure portion of the present invention on the opposite side of the non-rigid connection from the rotating broom mounting and control assembly includes a substantially stationary gooseneck assembly. The substantially stationary gooseneck assembly allows center point sweeping to the left or to the right of the self-propelled vehicle. The support structure further includes a swinging trunnion assembly which provides center point oscillation of the rotating broom assembly.

[0010] The combination of the center point oscillation and the non-rigid connection therebetween allows for vertical tracking of the rotating broom and continuous adjustment of the rotating broom to the various conditions encountered on the paved surface being swept. The use of a stationary gooseneck assembly, a swinging trunnion assembly, and a non-rigid connection therebetween provides superior performance characteristics over prior art truck-mounted rotating broom sweeping systems.

[0011] The support structure portion of the truck-mounted system of the present invention, by using the unique combination of a stationary gooseneck assembly and a swinging trunnion assembly, when combined with a non-rigid connection therebetween, provides the kinematics necessary for optimizing both the sweeping effectiveness of the rotating broom and the safe operation of the truck. In addition, the disclosed system for mounting, positioning, and powering a rotating broom allows for easy and reliable changing of the angular orientation of the rotating broom; that is, swinging the entire

rotating broom to either the left or to the right with respect to the front of the truck, by center oscillation of the yoke which supports the rotating broom.

[0012] The disclosed truck-mounted system for mounting, positioning, and powering a rotating broom segregates the weight of the rotating broom system into two separate sections. The first section, the weight of the rotating broom along with its drive assembly, is supported by pneumatic tire casters. The second section, the weight of the support structure, is supported by the self-propelled vehicle itself. In addition, the design of the truck-mounted system for mounting, positioning, and powering a rotating broom permits rotating brooms of different diameters to be easily and quickly installed by simply interchanging the broom pivot arms and then assembling the rotating broom with the desired diameter together with the appropriate hydraulic drive components.

[0013] The center point movement of the truck-mounted system for mounting, positioning, and powering a rotating broom about its axis allows the broom bristles to have a consistent contact pattern with the ground. Consistency of broom bristle contact pattern with the ground is a problem with prior art designs. The rotating broom mounting system of the present invention also reduces the negative impact on the drivability of the truck; specifically, vehicle lean caused by unequal loading on the vehicle's suspension. The disclosed truck-mounted rotating broom system provides weight transfer to the vehicle without the need for counterweights or special hydraulics.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0014] A better understanding of the disclosed truck-mounted system for mounting, positioning, and powering a rotating broom is included in the following awing figures, wherein:

Figure 1 is a perspective view of the truck mounted rotating broom system of the present invention;

Figure 2 is a side elevational view of the system shown in Figure 1;

Figure 3 is a perspective view of the substantially stationary gooseneck assembly;

Figure 4 is a perspective view of the swinging trunnion assembly;

Figure 5 is an exploded perspective view of the connection of the stationary gooseneck assembly to the swinging trunnion assembly;

Figure 6A is a rear perspective view of the combination of the substantially stationary gooseneck assembly, the swinging trunnion assembly, and the non-load bearing floating beam assembly;

Figure 6B is a front perspective view of the combination of assemblies shown in Figure 6A;

Figure 7 is a front perspective view of the rotating broom control mounting assembly connected to the combination of assemblies shown in Figures 6A and 6B; and

Figure 8 is a perspective view of an alternate embodiment of the system illustrated in Figure 1.

DESCRIPTION OF THE EMBODIMENTS

[0015] An introduction to a better understanding of the truck mounted system for mounting, positioning, and powering a rotating broom **10** of the present invention may be had by appreciating the large size of the rotating broom **110** that is used with the present invention for sweeping a paved surface. While rotating brooms **110** come in a variety of different sizes and the present invention is not limited by the size of the

rotating broom **110**, the preferred embodiment of the present invention was constructed for mounting a substantially cylindrical rotating broom **110** having a diameter from substantially three feet to a diameter of substantially four feet. The length of the substantially cylindrical rotating broom **110** is about eighteen feet. This eighteen foot broom is turned at speeds varying from 550 rpm to 800 rpm while the truck (not shown) used to move the rotating broom **110** over the paved surface to be swept is traveling at speeds of up to 35 mph.

[0016] While many substantially cylindrical rotating brooms use circular disks of bristles aligned across the length of the rotating broom, the preferred embodiment of the disclosed system uses cassettes of linear groups of bristles **112**. These cassettes of linear groups of bristles **112** are inserted into holders (not shown) which are to be mounted parallel to the long axis of the rotating broom **110**. The power to turn the substantially circular rotating broom is provided by any one of a variety of well known means, generally located on one or both ends of the rotating broom **110**. A hydrostatic pump and motor combination, where the hydrostatic pump is driven by the truck's engine and the motor is mounted in the broom pivot arm, is used in the preferred embodiment to provide the necessary power to turn the rotating broom **110**. Those of ordinary skill in the art will understand that both the selection of and the position for the drive components necessary to turn the rotating broom may be affected by a wide variety of design and operational considerations.

[0017] The design of the disclosed truck-mounted system for mounting, positioning, and powering a rotating broom solves a variety of interdependent problems. Starting with the tip speed at the end of each of the broom bristles, the effective uniform

sweeping of a paved surface requires even contact of the end of the broom bristles across the full length or span of the rotating broom **110**. Complicating this initial requirement for even contact of the bristle tips **114** with the paved surface is the coning of the shape of the substantially cylindrical rotating broom **110** from uneven wear patterns caused by a variety of factors, to include differing terrain conditions. As will be understood by those of ordinary skill in the art, the disclosed system can accommodate the coning of the shape of the substantially cylindrical rotating broom **110**.

[0018] Those familiar with the sweeping of paved surfaces, particularly airport runways, realize that when the truck reaches the end of the runway, the angular orientation of the rotating broom **110** must be changed to assure that the snow or debris continues to be displaced in the same direction off the runway or paved surface. In addition, the paved surface may be part smooth concrete, part smooth asphalt, and/or part rough asphalt. Accordingly, the truck mounted system 10 for mounting, positioning, and powering a rotating broom **110** of the present invention provides a constant pattern of contact of the tips **114** of the bristles **112** with the paved surface, irrespective of the angular orientation of the rotating broom **110** with respect to the direction of travel of the truck or irregularities in the paved surface.

[0019] While there may be some sweeping situations in which the long axis of the rotating broom assembly is substantially perpendicular to the long axis of the truck, most sweeping situations require that the long axis of the rotating broom **110** be angled up to 35 degrees away from the direction of travel of the truck. To minimize any negative effects on the handling characteristics of the truck, the point of rotation of the long rotating broom **110** is located on the centerline of the truck chassis. This placement

of the point of rotation of the long rotating broom **110** on the centerline of the truck chassis facilitates aligning the vehicle with the long axis of the paved surface being swept, particularly when the angular orientation of the long rotating broom is moved from left to right at the end of a sweeping run.

[0020] The management of the weight of the truck-mounted system **10** for mounting, positioning, and powering a rotating broom **110**, together with its drive components, is the distinguishing feature of the present invention. If all of the weight of the rotating broom mounting hardware and drive mechanism were hung from the front bumper or from the front of the truck frame, the center of gravity of the truck would shift dramatically forward. Such a dramatic forward shift in the center of gravity would place inordinate loads on the front suspension, steering system, and front tires. If a caster system is added to bear the weight of the rotating broom along with its mounting componentry and drive system, a slight mispositioning of the caster wheels would reduce the load on the suspension, steering system, and front tires of the truck. If reduced too much, such reduction in load on the front suspension, steering, and front tires would make the truck more difficult to control.

[0021] Even if the caster system is set up properly at the beginning of a sweeping run, the change in broom diameter because of bristle wear will distort the force geometry of the rotating broom sweeping system and thereby cause a change in the weight distribution on the front wheels of the truck, particularly the front axle assemblies.

[0022] The need to be able to easily modify the sweeping system for different sized brooms for different sweeping applications is also met by the present invention.

[0023] A still better understanding of the present system may be had by understanding, on a macro level, that the foregoing advantages of the disclosed system are obtained by segregating the weight of the truck-mounted system for mounting, positioning, and powering a rotating broom into two sections. The first section is the weight of the substantially cylindrical rotating broom itself, its mounting componentry, and the power system which causes the long rotating broom to turn so that the tips **114** of the bristles **112** move against the paved surface being swept. The second weight section is the structure connected to the truck which supports the weight of the long rotating broom, the mounting componentry, and the power system which causes the broom to rotate.

[0024] The first section, or the weight of the rotating broom itself, the mounting componentry, and the power system which causes the rotating broom assembly to turn are supported by a caster system **120**. The caster system **120** includes pneumatic tires **122** and an anti-wobble system (not shown). The anti-wobble system reduces the tendency of the caster wheels **122** to move back and forth rapidly during sweeping runs and thereby not track smoothly behind the long substantially cylindrical rotating broom **110**.

[0025] The second section of the weight is the support structure that is the part of the system supported by the chassis of the truck. As compared to prior art truck-mounted rotating broom systems, the segregation of the weight into two sections by the present invention provides distinct advantages. First, the weight supported by the caster system **120** is significantly reduced as compared to prior art truck-mounted rotating broom systems. Second, the weight supported by the chassis of the vehicle remains

relatively constant during a sweeping operation. This relatively constant supported weight assures that a controlled amount of weight is felt by the front axles of the truck. Control of the weight on the front axles of the truck assures better drivability and safe handling. In addition, the disclosed system facilitates changing brooms to brooms having different diameters, bristle composition, or bristle patterns.

[0026] A still better understanding of the present invention may be had by reference to Figures 1 and 2, which shows the assembled system, including the rotating broom control assembly **20** and the support structure **60** as they are mounted to the front of a vehicle. The main parts of the support structure include the substantially stationary gooseneck assembly **70** which mounts to the front of the truck, and the swinging trunnion assembly **80** which swings about a vertical axis is positioned below the stationary gooseneck assembly **70**.

[0027] A non-rigid connection **88** including floating beam assembly **90** is located on the bottom of the swinging trunnion assembly **80**.

[0028] The main component of the rotating broom control assembly **20** includes the mounting arm assembly or yoke **30** for the long, substantially cylindrical rotating broom **110** mounted to the floating beam assembly **90** of the non-load bearing connection **88**.

[0029] As shown in Figure 3, the substantially stationary gooseneck assembly **70** includes a plate **71** for attachment to the front of the truck. Extending outwardly from the plate **71** is a support arm **73** connected by structural gussets **75** located on either side of the plate **71**. At the end of the support arm **73** is a ring **77** whose use will be explained below.

[0030] Located just below the stationary gooseneck assembly **70** and as shown in Figure 4 is the swinging trunnion assembly **80**. At the outboard end of the swinging trunnion assembly **80** is a circular portion **81** whose utility for attachment to the stationary gooseneck assembly **70** will be explained below. Extending downwardly and at an angle from the circular portion **81** of the swinging trunnion assembly **80** is a support beam **83** which terminates in a mounting plate **85** for the non-rigid connection **88**. As shown in Figure 6B, optional access plates **87** may be placed on top of the support beam **83**.

[0031] The connection of the swinging trunnion assembly **80** to the stationary gooseneck assembly **70** is shown in Figure 5. A steering yoke **61** passes through the ring **77** at the end of the stationary gooseneck assembly **70** into the circular portion 81 at the end of the swinging trunnion assembly **80**. To facilitate the rotation of the swinging trunnion assembly **80** with respect to the stationary gooseneck assembly **70**, a swing bearing **63** is placed between the stationary gooseneck assembly **70** and the swinging trunnion assembly **80**. Movement of the swinging trunnion assembly **80** with respect to the stationary gooseneck assembly **70** is accomplished by the use of two linear steering cylinders **65**, as shown in Figure 6A. Each of the two linear steering cylinders **65** is attached to the steering yoke **61**. The steering yoke **61** is rigidly affixed to the swinging trunnion assembly **80** and to a mounting bracket **67** positioned on the top of the support arm **73** of the stationary gooseneck assembly **70**. Thus, when one of the two linear steering cylinders **65** is caused to extend in length and the other is caused to contract in length, the swinging trunnion assembly **80** will swing about a vertical axis with respect to the stationary gooseneck assembly **70**.

[0032] As previously indicated, the bottom of the swinging trunnion assembly **80** includes a non-rigid connection system **88** including a floating beam assembly **90**. This multi-directional, non-load bearing connection system **88** for the floating beam **90** assembly includes a four bar linkage connection **102** in the preferred embodiment. The four bar **102** linkage connection shown includes two bars on each side; however, other numbers of bars may be used.

[0033] The inner ends **104** of the four bars **102** are pivotably connected to the end of the swinging trunnion assembly **80**, and the outer ends 106 of the four bars **102** are pivotably connected to the floating beam **90** as shown in Figure 6B. Oscillation bearings **93** on shaft **92** facilitate the pivoting action of the rotating broom **110**. Because of the criticality of this connection to the operability of the disclosed invention, the preferred embodiment of the non-rigid connection **88** incorporates a sealed spherical **95** bearing at each end of the linkage bars **102**.

[0034] As shown in Figure 6B, the front of the floating beam **90** includes oscillation stops **97** for positioning of the long rotating broom. As shown in Figure 6A, rubber float stops **99** control the up and down movement of the rotating broom **110**.

[0035] Those of ordinary skill in the art will understand that foregoing construction provides a substantially rigid support system whose weight is supported by the truck. This substantially rigid support system includes the stationary gooseneck assembly **70** and the swinging trunnion assembly **80**. It is the use of the non-load bearing connection **88** to connect the floating beam assembly **90** which enables the weight of the rotating broom control assembly **20**, including the mounting componentry

and the drive mechanism to be managed separately from the weight of the support system **60**.

[0036] As shown in Figure 7, a yoke **22** for holding the rotating broom **110** and its drive system is attached to the floating beam assembly **90**. Tilt of the yoke **22** with respect to the floating beam assembly **90** is about the shaft **92** previously described. The yoke **22** consists of a long beam **24** attached to the floating beam assembly **90**. The long beam **24** includes a left portion **24L**, a right portion **24R**, and a center portion **24C**. At both ends of the left portion and the right portion of the long beam **24** is located a rotating pivot arm **32** for the rotating broom **110**. This rotating pivot arm **32** permits the long axis of the rotating broom **110** to move up and down with respect to the long beam **24**. The position of the rotating pivot arms **32** on each end of the long beam **24** is controlled by a pivot arm actuator cylinder **26**. Extending downwardly and placed on the left portion and on the right portion of the long beam **24** is a dual wheel caster assembly **120** which includes an anti-wobble system, The anti-wobble system prevents wobbling of the caster wheels during a sweeping operation.

[0037] As shown in Figures 1 and 8, once the long cylindrical rotating broom **110** is mounted between the rotating pivot arms **32**, the top of the long cylindrical rotating broom **100** may be enclosed with a cover assembly **130**. Depending on the type of sweeping conditions encountered, the cover assembly **130** may include a directional flap for **132** directing snow or debris in a desired direction. An optional dump cover assembly **140** is shown in Figure 8.

[0038] Those of ordinary skill in the art will now understand the assembly which positions the long rotating cylindrical broom and its drive mechanism moves effectively

independently from the motion of the truck because of the four bar linkage between the floating beam assembly **90** and the swinging trunnion assembly **80**. Up and down motion of either end of the rotating broom **110** is provided by the pivotable mounting of the beam **24** to the floating plate assembly **90**. Thus, any variation in terrain experienced by the tip of the broom bristles and transmitted back to the mounting for the broom results in movement of the floating beam assembly **90** and is not transmitted back to the truck chassis.

[0039] Rotation of rotating cylindrical broom assembly around its long axis is accomplished by one or more hydraulic motors located at the end of the rotating cylindrical broom, preferably in the broom pivot arm **32**. Should up or down movement of either end of the rotating cylindrical broom **110** be required because of unusual terrain conditions, the hydraulic cylinders used to control the position of the broom pivot arms are actuated so that either end of the rotating broom **110** may be moved up or down. Angular positioning of the rotating broom **110** with respect to the chassis of the truck is controlled, as previously indicated, by swinging the trunnion assembly **80** with respect to the stationary gooseneck assembly **90**. Such movement of the swinging trunnion assembly **80** will not affect the ability of the floating beam assembly **90** to move, thereby separating rotating broom movement from movement of the swinging trunnion assembly **80** the stationary gooseneck assembly **70**.

[0040] Utilization of rotating brooms having differing diameters is easily accomplished by removing the pivot arm **32** at the end of the long beam **24**, removing the rotating broom **110**, and replacing it with another rotating broom, and then replacing the broom pivot arm **32**.

[0041] While the disclosed system has been described according to its preferred embodiment, those of ordinary skill in the art will understand that numerous other embodiments have been enabled by the foregoing disclosure. Such other embodiments shall be included within the scope and meaning of the appended claims.